Synopsis

PhD in Special Education

EFFECTIVENESS OF COGNITIVE STRATEGIES TO ENHANCE ARITHMETIC SKILLS AND WORKING MEMORY AMONG STUDENTS WITH MILD INTELLECTUAL DISABILITY

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1.1 INTRODUCTION

Mathematics is used greatly in everyday life. Arithmetic is the foundation upon which all other advanced mathematics is built. It is the mathematical aspect that people are most familiar with. It deals with real numbers and calculations. Our ability to perform arithmetic skills relies on several underlying factors like specific knowledge and skill training as well as general cognitive abilities. One of the cognitive ability that play a key role in arithmetic performance is working memory.

Working memory is a cognitive mechanism that manages and stores data in order to organize diverse activities, such as keeping an action goal or holding a conversation (Baddeley, 2003). Working memory is the most widely used term in Psychology that helps to keep information in an individual's mind to execute cognitive tasks. It is often related to intelligence and information processing skills. In the case of arithmetic learning, working memory is the active memory, students get engaged in solving or computing a new problem, interpret the information received from the teacher by using information retrieved from the long-term memory and form new mathematical knowledge, i.e., solving or computing a mathematical problem.

Literature shows that working memory is related to a variety of numerical and mathematical abilities used for counting, which underline the solution of simple addition and subtraction problems as well as the solution for complex arithmetic problems (Adams & Hitch, 1997; Passolunghi & Pazzaglia, 2004).

Studies have shown that specifically designed mental exercises or strategies can enhance working memory performance. Swanson, Lussier and Orosco (2013) examined the effect of strategy instruction and working memory capacity on word problem-solving accuracy in children with or without math difficulties. Strategic instruction is found to be the best tool for increasing working memory capacity on word problem-solving accuracy. Krawec et al (2012) examined the effects of cognitive strategy on math problem-solving for middle school students with learning disabilities. They observed that cognitive strategies help the students to improve significantly in mathematical problem-solving skills.

Cognitive strategies are procedures that help students to learn more successfully. There are several activities included in cognitive strategies like summarising meaning,

imagery for memorization, organising new language, repetition and guessing meaning from context. A cognitive strategy serves to support the learners and help to develop internal procedures that enable them to perform complex tasks. The strategies selected for this study are graphic organizers, visualizers and rehearsal. Graphic organizers are diagrammatic illustrations designed to assist students in representing patterns, interpreting data and analysing information relevant to the problem. In the visualisation strategy, pictorial representations are used for arithmetic problems. Rehearsal is a strategy of repeated practice of specific information to learn it. When a student is presented with some specific information to learn, for example learning addition or multiplication table, often he will try to memorize the information by repetition. This strategy is useful for learning basic information.

Students with Intellectual Disability

Intellectual disability is a condition characterised by impaired cognitive function and adaptive behaviour. Individuals with intellectual disability have an IQ of under 70 and deficits in adaptive behaviour such as conceptual, social and practical skills. Conceptual skills include language, self-direction and basic academic skills; social skills encompass interpersonal and intrapersonal skills; practical skills include personal care, occupational skills, money management, transportation and the ability to follow schedules/ routines (Schalock, et al., 2010).

Students with intellectual disability can be classified as mild, moderate, severe, and profound based on the functioning of their intellectual abilities. Children with mild intellectual disability can be provided instruction and training to develop self-help skills, interpersonal skills, and academic skills. Among the population of the world, one per cent of people are affected with intellectual disability among them 85% are with mild intellectual disability (American Psychiatric Association 2013).

Teaching Academics to Students with Intellectual Disability

Academics refer to skills involved in the areas of reading, writing, numeracy, technology and environmental studies. formed part of everyday classroom environment of students. Students with intellectual disability engage in academic activities that help them to acquire basic reading, writing and arithmetic skills in a practical manner that relate these skills to real-life situations.

Students with intellectual disability exhibit delay in cognitive, social and adaptive behaviour skills in the classroom when compared to their normal classmates, but with

appropriate support, they can achieve their maximum potential both in academics and in their day-to-day activities leading to independent living.

Students with intellectual disability need functional age-appropriate and community-referenced educational goals and objectives (Narayan & Thressiakutty, 2007). Functional academic skills are the skills and abilities which is useful in everyday life. It includes literacy, numeracy and technological skills and knowledge which help students with intellectual disability to access a variety of real-life experiences. One of the important functional academic area is arithmetic.

Functional arithmetic includes pre-computational, computational, application and problem-solving skills. Basic arithmetic skills like number skills and basic computational skills are considered very useful in their daily life situations. This knowledge is also important to rehabilitate children with intellectual disability both socially and economically.

Teaching arithmetic to students with intellectual disability has long been a priority of Special Educators. When compared to other academic areas (eg., reading & writing) children with intellectual disability face difficulty in the application of arithmetic skills in their daily life situations. The low intellectual functioning makes it difficult for these children to understand abstract concepts.

According to studies, students with intellectual disability can succeed in their academic endeavours provided they are motivated and their educational demands are satisfied with the help of efficient instructional resources (Baker et al. 2015; Hudson, Rivera and Grady 2018; Spooner et al. 2019). Since the needs of each student with an intellectual disability are unique, they need appropriate teaching strategies to learn the task. There are different instructional strategies, choosing a particular strategy depends on the teacher's choice, the nature of the task and the learner characteristics.

1.2. NEED AND SCOPE OF THE STUDY

Learning is a complex, ongoing process of obtaining skills and knowledge in the context of education. The development of cognitive skills is crucial for academic learning. Studies have demonstrated the importance of working memory in the learning process (Gathercole et al 2005; Passolunghi&Lanfranchi 2012). Working memory is not for storing information, but an ability to work with the information. In school, while learning academic subjects, children use working memory as a mental space in which the active manipulation of information is processed (Gathercole&Alloway 2008).

The educational strategy for students with special needs has evolved over the past few decades from segregation to inclusion. It is the outcome of the global movement for an

inclusive society and the shifting attitudes in society. Today's education policy is focused on including students with special needs in general education classes. Inclusive education is that all students without considering their abilities enrol in the same classroom and access all the facilities and actively participate in all aspects of school life. An inclusive classroom consists of diverse learners where their individual needs and unique abilities should be recognised and valued. In mainstream classrooms, general teachers use common teaching that will not help students with intellectual disability. They need special techniques or strategies to learn academic tasks. Cognitive and metacognitive strategies are proven to be effective in teaching academics to students with intellectual disability.

. Cognitive methods are practical aids for helping pupils who struggle with learning. When addressing a learning activity, the learner is more effective when using cognitive techniques. Cognitive techniques enable active, beneficial, and lasting learning. It stimulates participation in the learning process on the part of the students.

Learning arithmetic skills act as an essential component of education. Difficulty in understanding and using arithmetic skills strongly affect academics as well as the everyday functioning of the child. Several cognitive mechanisms may underpin the development of arithmetic skills in children. Among that working memory capacity has a great significance for developing arithmetic skills in children. From the literature, it is clear that there is a strong link between arithmetic performance and working memory in children (Gathercole et al, 2005; Toll et al 2011).

Cognitive development is delayed in students with intellectual disabilities. According to research findings, children with poor math skills also struggle with working memory (Geary, 1993; Swanson, 1993), making it difficult for them to store knowledge in memory while engaging in other activities and to suppress irrelevant information.

Studies showed that specifically designed mental exercises or strategies can enhance working memory performance. Swanson (2013) examined the impact of working memory capacity and strategy instruction on word problem-solving accuracy in children with or without arithmetic challenges. It has been determined that strategic instruction is the most effective method for boosting working memory capacity and accuracy in word problem-solving. Krawec et al. (2012) looked at how the cognitive approach affected middle school pupils with learning difficulties when they were doing math problems. They discovered that cognitive strategies greatly aid students' development of mathematical problem-solving skills.

A link between working memory, mathematical problem-solving, and intellectual disability was also revealed through research studies. However, very limited studies are there to analyse the role of cognitive strategies to improve working memory and arithmetic skills. Hence, the present study is planned to find out the effect of cognitive strategies in improving arithmetic skills and related working memory skills among students with mild intellectual disability. A study like this is essential for finding the existing performance of students with intellectual disability on arithmetic skills in an inclusive classroom and also the need for special strategies.

The result of the study highlights the significant role of cognitive strategies in learning arithmetic. With its positive impact, the class teachers can continue the strategy not only to teach arithmetic skills but also use to teach other academic subjects with necessary adaptations. The investigator hopes that the result of the study is expected to highlight the need and importance of following specific strategies used to teach students with intellectual disability. Thus the findings of the study will make a positive impact on the education of students with mild intellectual disability in mainstream classrooms. The findings will lead to the use of effective and innovative teaching strategies in the classrooms especially for special needs children.

The results of this study will help policymakers to gain a clear understanding of the current state of education for students with intellectual disabilities in an inclusive environment. Policymakers can take action to enhance the learning outcomes of students with disabilities by providing guidance to teachers on the use of specific teaching techniques, making curriculum modifications, and making policy-related modifications.

1.3. STATEMENT OF THE PROBLEM

Working memory, arithmetic learning and IQ are interrelated. Students with intellectual disabilities typically have a low-level IQ, resulting in low cognitive abilities. These cognitive deficiencies are reflected in their academic performance. In mainstream classroom settings, mild intellectual disability students were typically forced to adhere to the general curriculum. Similarly, teachers often find it challenging to teach these students by adhering to traditional teaching techniques. In such cases, specialized teaching techniques, such as cognitive strategies, are beneficial for the academic success of special needs children.

The present study attempts to examine the effect of cognitive strategies to enhance arithmetic skills and working memory among students with mild intellectual disability studying in primary-level inclusive schools in Kerala.

Hence, the problem is stated as:

"Effectiveness of Cognitive Strategies to Enhance Arithmetic Skills and Working Memory among Students with Mild Intellectual Disability."

1.4 OPERATIONAL DEFINITIONS

Effectiveness: Effectiveness is the enhancement of the performance of students with mild intellectual disability in the areas of arithmetic and working memory by cognitive strategies.

Cognitive strategies: Cognitive strategies are procedures that help students to learn better. In the present study cognitive strategies means specific cognitive strategies such as visualization, graphic organizers and rehearsal.

Enhance: In this study, "enhance" refers to improvements in students with mild intellectual disabilities in certain arithmetic skills, such as number sequence, place value identification, and whole number operation, as well as in visual-spatial and working memory skills.

Working memory: Working memory is a cognitive system with a finite capacity that can temporarily store knowledge. Here, working memory refers to the visuospatial and auditory working memory performance of students with mild intellectual disability as a result of assessment using a working memory tool.

Students with Mild Intellectual Disability: Mild intellectual disability is a condition that is characterised by deficits in intellectual functioning and adaptive behaviour in the students. Before the age of 22, these deficiencies are manifested. An IQ of 50 to 70 is considered mild intellectual disability (AAIDD 2010).

In this study, students with mild intellectual disability means, children who possess an IQ level 55-70, studying in 5^{th} and 6^{th} Grades in mainstream schools under Samagra Shiksha Abhiyan, Kerala.

1.5. VARIABLES OF THE STUDY

- Independent Variable: Cognitive Strategies such as graphic organizer, Visualization and Rehearsal.
- Dependent variables:
    - Arithmetic Skills - (Number Sequencing, Place Value Identification and Whole Number Operation)
    - Working Memory - (Visuo-spatial and Auditory Working Memory)

1.6 OBJECTIVES OF THE STUDY

The major objectives of the study was to:

- develop Arithmetic Assessment Tool for Students with Mild Intellectual Disability.
- develop Working Memory Tool for Students with Mild Intellectual Disability.
- find out the level of arithmetic skills among students with mild intellectual disability
- find out the level of working memory among students with mild intellectual disability.
- determine the effectiveness of cognitive strategies on selected arithmetic skills.
- determine the effectiveness of cognitive strategies on selected Working Memory skills.
- To analyse the impact of cognitive teaching strategies on arithmetic skills with respect to selected socio-demographic variables.
- To determine the impact of cognitive teaching strategies on working memory skills with respect to selected socio-demographic variables.

1.7 HYPOTHESIS FORMULATED FOR THE STUDY

- There is no significant difference in the overall performance on number sequencing skills among students with mild intellectual disability before and after the intervention.
- There is no significant difference in the overall performance on place value identification skills among students with mild intellectual disability before and after the intervention.

- ❖ There is no significant difference in the overall performance on whole number operation skills among students with mild intellectual disability before and after the intervention.
- ❖ There is no significant difference in the overall performance on visuo-spatial working memory skills among students with mild intellectual disability before and after the intervention.
- ❖ There is no significant difference in the overall performance on auditory working memory skills among students with mild intellectual disability before and after the intervention.
- ❖ Arithmetic performance of students with mild intellectual disability do not differ significantly with respect to selected socio-demographic variables.
- ❖ Working memory scores of students with mild intellectual disability do not differ significantly with respect to selected socio-demographic variables.

1.8 METHODOLOGY

The study followed a single-group pre-test, post-test, and follow-up design. The sample chosen for the study consisted of 30 students with mild intellectual disability studying in 5th and 6th grades in various mainstream schools in Malappuram district, Kerala.

Two tools were developed by the investigator.

- Arithmetic Assessment Tool (AAT): This tool was developed to assess the current leel performance of students with mild intellectual disability on arithmetic skills. It was developed by reviewing the SCERT Kerala syllabus Textbook. There were 90 items in the tool grouped under five domains.
- Working Memory Assessment Tool (WMAT)) was developed for the study. The tool included 30item arranged under five domains, which assess the visuo-spatial and auditory working memory of students with mild intellectual disability.
- The investigator also developed a Personal-Social Information Profile (PSIP) to collect the personal and family details of the sample.

The study was conducted in five phases. In the first phase, the investigator got permission from the Director of Public Education, Kerala. Then select the required sample with the help of resource teachers by using stratified sampling method. The second phase involved the collection of demographic details of the samples and pre-test using the developed tools. Along with this the parental consent form permitting their child to participate in the study was

obtained from each parent. The third phase was the intervention phase, where the investigator applied cognitive strategies to teach arithmetic skills. This included the use of graphic organizers, charts, flashcards, and pictures. The training was conducted for one hour every day. It lasts for 6 months. The next phase was the post-test. A post-test was done using the same tools. After one month of the post-test, a follow-up test was conducted to find out the sustainability of the performance.

1.9DATA ANALYSIS

The collected data were tabulated and analysed using SPSS Software. The following statistical techniques were used to analyse the data.

- Measures of central tendency
- Percentage analysis
- Paired sample t-test
- Repeated measures of ANOVA
- Bonferroni test of significant difference for post hoc comparison
- Analysis of Covariance (ANCOVA)

1.10 Major Findings

- ❖ Cognitive strategies found to be an effective method in enhancing arithmetic skills among students with mild intellectual disability.
- ❖ There exists a significant difference in the pre-test and post-test mean scores on number sequencing skills. It shows the effect of cognitive strategies to enhance number sequencing skills among 5^{th} and 6^{th} Grade students with mild intellectual disability.
- ❖ It is found that the mean value difference of pre-test and post-test scores of students with mild intellectual disability on place value identification is highly significant. It proved that the selected cognitive teaching strategies are effective in teaching place value identification to students with mild intellectual disability.
- ❖ It has been found that the selected cognitive teaching strategies are effective in teaching whole number operations.
- ❖ The findings of the study on visuo-spatial working memory showed that there is a significant improvement in visuo-spatial working memory among students with mild

intellectual disability. It highlighted the effectiveness of selected cognitive teaching strategies to enhance working memory skills.

- There exists no difference in the pre and post-test mean values of auditory working memory. It pinpointed that the cognitive strategies have no effect on improving the auditory working memory skills in this study.
- There exists no noticeable difference in the achievement of arithmetic skills among students with mild intellectual disability before and after intervention with respect to selected socio demographic variables (gender, class and type of school). Hence it can be stated that these variables are not significant factors in learning arithmetic skills.
- Comparison of the effectiveness of selected cognitive teaching strategies on working memory among students with mild intellectual disability with respect to the selected demographic variables (gender, class and type of school) revealed that there is no significant difference in the pre-test and post-test mean values. Thus it can be said that these variables have no significant influence on increasing working memory skills among students with mild intellectual disability

1.11 IMPLICATIONS

The findings of the study revealed that selected cognitive teaching strategies, such as graphic organizers and visualizers are effective in enhancing arithmetic skills and working memory skills among students with mild intellectual disability. As the findings highlighted the positive impact of cognitive teaching strategies, the class teachers can continue the use of such strategies in their classrooms. The use of concept maps, charts, pictures, and flashcards increased the interest as well as the attention of the students towards the particular task. The class teachers can also adapt and use the strategies for teaching other academic subjects.

The study also helps to identify the problems faced by students with mild intellectual disability in arithmetic. With this, the general teachers can select appropriate teaching strategies with the help of resource teachers.

1.12 SUGGESTIONS FOR FURTHER RESEARCH

The results of this study have opened up new avenues of investigation. While conducting research in related fields, the following recommendations can be taken into account.

- The impact of cognitive strategies on academic subjects other than math may be investigated.

- The same study can be done by incorporating complex mathematical skills.
- Further research can be conducted on another type of disabilities.
- A study like this can be done with children with moderate intellectual disability.
- Investigation may be done on how well general education teachers know about specific teaching strategies and how often they use them in the classroom.
- With the intervention strategies found to be significant, paves the way for experimentation on a larger sample.
- Only children who were enrolled in the state curriculum were included in the current study. The study can be replicated in CBSE schools.
- Effectiveness of other cognitive strategies in different academic areas can be done.

1.13 LIMITATIONS

- The study is limited to only three arithmetic skills, number sequencing, place value identification and whole number operation.
- The size of the sample for the study was limited to 30, large sample group can strengthen the findings of the study.
- The investigator relied solely on the information from the school records to select the students with a mild intellectual disability. An Administration of IQ test would have yielded a more accurate outcome.
- Only one group (experimental group) is included in the present study. A more accurate result would have been obtained if there was a control group.

1.14 CONCLUSION

Arithmetic is a branch of mathematics that act as a useful tool in everyday activities. Learning arithmetic skills enable students with mild intellectual disability to function independently in their environment. The present study used cognitive strategies such as graphic organizers, visualization, and rehearsal to teach arithmetic skills to students with mild intellectual disability and also assessed whether there is any improvement in their working memory performance as a result of the intervention programme. The study proved that the intervention programme was effective in improving the arithmetic as well as working memory skills in students with mild intellectual disability.

Students with intellectual disabilities have a set of unique characteristics which differentiate them from their normal peers and hinder their inclusion in mainstream education. The most important factor is to find out the unique abilities and develop, that through the use of specific strategies. To conclude an inclusive classroom is a pool of diverse

learners. It is the responsibility of the classroom teacher to find out the diverse learning requirement of each student and train them according to their needs. Thus parents, community members, policymakers, and all other stakeholders work together and make inclusion real.

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